

WHAT IS CLAIMED IS:

1. A communication spacecraft for providing cellular communications among a plurality of user terminals and ground stations, by way of paths having a bandwidth generally suited for audio signals, and for also providing communications among at least said ground stations by way of at least one path having a bandwidth at least five times greater than said bandwidth suitable for audio signals, said spacecraft comprising:
  - a downlink antenna including a plurality of antenna elements, for receiving guided electromagnetic energy at each of said antenna elements, and for radiating said energy in the form of unguided radiation:
  - an analog beamformer including a plurality of beam input ports and a plurality of elemental antenna ports, each of which is coupled to one of said antenna elements, for producing at least one independent beam of electromagnetic downlink radiation from guided energy applied to each of said beam input ports, so that plural downlink antenna beams are formed when signals are applied to a plurality of said beam input ports of said analog beamformer;
  - receiving means for receiving unguided electromagnetic uplink radiation including at least one carrier, and for at least transducing said unguided electromagnetic uplink radiation into guided electromagnetic

energy on a plurality of separate paths;

35 a narrowband digital channelizer  
having individual channel bandwidths suitable  
for audio signals, said channelizer including a  
plurality of input ports and a plurality of  
output ports, at least some of said input ports  
of said digital channelizer being coupled by  
way of corresponding ones of said plurality of  
40 separate paths to said receiving means, for  
receiving said guided electromagnetic energy  
from a plurality of said separate paths, and  
for extracting each of said independent  
narrowband signals from said at least one  
45 carrier, to thereby produce separated  
independent narrowband signals on said  
plurality of output ports of said digital  
channelizer;

50 a wideband channelizer having an  
individual channel bandwidth at least five  
times greater than that of an individual  
channel of said narrowband channelizer, said  
wideband channelizer being coupled to at least  
a portion of said receiving means, for  
55 extracting at least one wideband signal from  
said carrier, to thereby produce separated  
independent wideband signals;

60 a switching arrangement coupled to  
said plurality of output ports of said  
narrowband channelizer and to said wideband  
channelizer, for receiving said independent  
narrowband signals and said wideband signals,  
and for grouping together those signals

65 associated with each of said plural downlink  
antenna beams, to thereby produce combined  
signals grouped by beam, where said combined  
signals may include any number of said wideband  
signals, including the number zero; and

70 a coupling arrangement coupled to  
said switching arrangement and to said  
beamformer, for coupling said combined signals  
grouped by beam to that one of said input ports  
of said beamformer associated with the beam of  
said group.

2. A communication spacecraft for  
providing cellular communications among a  
plurality of user terminals and ground  
stations, by way of paths having a bandwidth  
5 generally suited for audio signals, and for  
also providing communications among at least  
said ground stations by way of at least one  
path having a bandwidth at least five times  
greater than said bandwidth suitable for audio  
10 signals, said spacecraft comprising:

an uplink antenna including a  
plurality of antenna elements, for receiving  
unguided electromagnetic energy including at  
least one uplink carrier at each of said  
15 antenna elements, and for transducing received  
unguided radiation into guided waves at a  
guided-wave port:

an analog beamformer including a  
plurality of beam output ports and a plurality  
20 of elemental antenna ports, each of which is

coupled to one of said antenna elements, for  
producing at least one independent uplink  
antenna beam signal at each of said beam output  
ports from guided energy applied to said  
25 elemental antenna ports, so that plural uplink  
antenna beam signals are formed when signals  
are applied to a plurality of said elemental  
antenna ports of said analog beamformer;

receiving means for receiving said  
30 uplink antenna beam signals, and for at least  
downconverting said uplink antenna beam signals  
to produce downconverted uplink antenna beam  
signals;

a narrowband digital channelizer  
35 having individual channel bandwidths suitable  
for audio signals, said channelizer including a  
plurality of input ports and a plurality of  
output ports, at least some of said input ports  
of said digital channelizer being coupled by  
40 way of separate paths to said receiving means,  
for receiving said downconverted uplink antenna  
beam signals, and for separately processing  
each of said independent narrowband signals in  
a manner which associates each of said  
45 independent narrowband signals with other such  
independent narrowband signals destined for a  
particular downlink antenna beam, to thereby  
produce independent narrowband signals combined  
on a beam-destination basis on said plurality  
50 of output ports of said digital channelizer;

a wideband channelizer having an  
individual channel bandwidth at least five

times greater than that of an individual  
channel of said narrowband channelizer, said  
55 wideband channelizer being coupled to at least  
a portion of said receiving means, for  
extracting at least one wideband signal from  
the received signal, to thereby produce  
separated independent wideband signals;  
60 a switching arrangement coupled to  
said plurality of output ports of said  
narrowband channelizer and to said wideband  
channelizer, for receiving said independent  
narrowband signals and said wideband signals,  
65 and for grouping together those signals  
associated with each of said plural downlink  
antenna beams, to thereby produce combined  
signals grouped by beam, where said combined  
signals may include any number of said wideband  
70 signals, including the number zero; and  
a coupling arrangement coupled to  
said switching arrangement and to said  
beamformer, for coupling said combined signals  
grouped by beam to that one of said input ports  
75 of said beamformer associated with the beam of  
said group.

3. An apparatus according to claim  
2, wherein said downconverting means  
downconverts said downconverted uplink antenna  
beam signals to baseband.

4. An apparatus according to claim  
2, wherein said narrowband digital channelizer

5 further comprises return link upconverters  
associated with at least some of its output  
ports, for upconverting said independent  
narrowband signals to an intermediate  
frequency.

5 5. An apparatus according to claim  
3, wherein said wideband channelizer comprises  
an upconverter for upconverting said  
downconverted uplink antenna beam signals to  
produce upconverted received signals.

6. An apparatus according to claim  
5, wherein said wideband channelizer comprises  
at least one wideband filter for filtering said  
upconverted received signals.

7. A method for transmitting,  
through an analog beamformer, wideband signals  
and at least some of a plurality of independent  
signals, each of which independent signals has  
5 a bandwidth no greater than one-fifth of that  
of said wideband signals, said method  
comprising the steps of:

10 receiving unguided electromagnetic  
radiation including (a) a plurality of said  
independent signals ]]having bandwidths  
suitable for audio use, each of said  
independent signals being modulated onto a  
subcarrier which is in turn modulated onto a  
carrier and (b) said wideband signals, to  
15 thereby produce guided electromagnetic energy

signals representing combined wideband signals  
and narrowband independent channels;

channelizing said signals  
representing combined wideband signals and  
20 narrowband independent channels, to thereby  
extract separated independent narrowband  
signals;

channelizing said signals  
representing combined wideband signals and  
25 narrowband independent channels, to thereby  
extract separated wideband signals;

combining those of said separated  
independent narrowband signals and said  
separated wideband signals which are associated  
30 to be downlinked over a particular downlink  
antenna beam, to thereby produce antenna beam  
signals;

beamforming said antenna beam signals  
to produce plural antenna element guided wave  
35 signals; and

coupling each of said antenna element  
guided wave signals to the guided wave input  
port of a different antenna element of an  
antenna array.

8. A method according to claim 7,  
wherein said step of channelizing said signals  
representing combined wideband signals and  
narrowband independent channels, includes the  
5 step of digitally channelizing said combined  
wideband and narrowband independent channels.

9. A method according to claim 7,  
wherein said step of channelizing includes the  
step of limiting the bandwidth of each of said  
independent signals to a bandwidth suitable for  
5 carrying of intelligible audio.

10. A method according to claim 9,  
wherein said step of limiting the bandwidth  
includes the step of limiting each of said  
independent signals to a bandwidth of no more  
5 than 10 KHz.